

SEQUENCE LISTING

<110>KAO CORPORATION

<120>New mutant alpha-amylase

<130>

<150>JP P1999-163569

<151>1999-06-10

<160>23

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<211>480

<212>PRT

<213>Bacillus sp. KSM-K38

<400>1

Asp Gly Leu Asn Gly Thr Met Met Gln Tyr Tyr Glu Trp His Leu Glu

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Asn Asp Gly Gln His Trp Asn Arg Leu His Asp Asp Ala Ala Ala Leu

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25

30

Ser Asp Ala Gly Ile Thr Ala Ile Trp Ile Pro Pro Ala Tyr Lys Gly

35

40

45

Asn Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu

|   |   |     |
|---|---|-----|
| 50  | 55                                      | 60  |
| Gly Glu Phe Asn Gln Lys   | Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys |     |
| 65  | 70                                      | 75  |
| Ala Gln Leu Glu Arg Ala Ile Gly Ser Leu Lys Ser Asn Asp Ile Asn |   | 80  |
|   | 85                                      | 90  |
| Val Tyr Gly Asp Val Val Met Asn His Lys Met Gly Ala Asp Phe Thr |   | 95  |
| 100   | 105                                     | 110 |
| Glu Ala Val Gln Ala Val Gln Val Asn Pro Thr Asn Arg Trp Gln Asp |   |     |
| 115   | 120                                     | 125 |
| Ile Ser Gly Ala Tyr Thr Ile Asp Ala Trp Thr Gly Phe Asp Phe Ser |   |     |
| 130   | 135                                     | 140 |
| Gly Arg Asn Asn Ala Tyr Ser Asp Phe Lys Trp Arg Trp Phe His Phe |   |     |
| 145   | 150                                     | 155 |
| Asn Gly Val Asp Trp Asp Gln Arg Tyr Gln Glu Asn His Ile Phe Arg |   | 160 |
|   | 165                                     | 170 |
| Phe Ala Asn Thr Asn Trp Asn Trp Arg Val Asp Glu Glu Asn Gly Asn |   | 175 |
| 180   | 185                                     | 190 |
| Tyr Asp Tyr Leu Leu Gly Ser Asn Ile Asp Phe Ser His Pro Glu Val |   |     |
| 195   | 200                                     | 205 |
| Gln Asp Glu Leu Lys Asp Trp Gly Ser Trp Phe Thr Asp Glu Leu Asp |   |     |
| 210   | 215                                     | 220 |
| Leu Asp Gly Tyr Arg Leu Asp Ala Ile Lys His Ile Pro Phe Trp Tyr |   |     |
| 225   | 230                                     | 235 |
| Thr Ser Asp Trp Val Arg His Gln Arg Asn Glu Ala Asp Gln Asp Leu |   | 240 |
|   | 245                                     | 250 |
| Phe Val Val Gly Glu Tyr Trp Lys Asp Asp Val Gly Ala Leu Glu Phe |   | 255 |

|   |     |     |
|---|-----|-----|
| 260   | 265 | 270 |
| Tyr Leu Asp Glu Met Asn Trp Glu Met Ser Leu Phe Asp Val Pro Leu |     |     |
| 275   | 280 | 285 |
| Asn Tyr Asn Phe Tyr Arg Ala Ser Gln Gln Gly Gly Ser Tyr Asp Met |     |     |
| 290   | 295 | 300 |
| Arg Asn Ile Leu Arg Gly Ser Leu Val Glu Ala His Pro Met His Ala |     |     |
| 305   | 310 | 315 |
| Val Thr Phe Val Asp Asn His Asp Thr Gln Pro Gly Glu Ser Leu Glu |     |     |
| 325   | 330 | 335 |
| Ser Trp Val Ala Asp Trp Phe Lys Pro Leu Ala Tyr Ala Thr Ile Leu |     |     |
| 340   | 345 | 350 |
| Thr Arg Glu Gly Gly Tyr Pro Asn Val Phe Tyr Gly Asp Tyr Tyr Gly |     |     |
| 355   | 360 | 365 |
| Ile Pro Asn Asp Asn Ile Ser Ala Lys Lys Asp Met Ile Asp Glu Leu |     |     |
| 370   | 375 | 380 |
| Leu Asp Ala Arg Gln Asn Tyr Ala Tyr Gly Thr Gln His Asp Tyr Phe |     |     |
| 385   | 390 | 395 |
| Asp His Trp Asp Val Val Gly Trp Thr Arg Glu Gly Ser Ser Ser Arg |     |     |
| 405   | 410 | 415 |
| Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asn Gly Pro Gly Gly Ser |     |     |
| 420   | 425 | 430 |
| Lys Trp Met Tyr Val Gly Arg Gln Asn Ala Gly Gln Thr Trp Thr Asp |     |     |
| 435   | 440 | 445 |
| Leu Thr Gly Asn Asn Gly Ala Ser Val Thr Ile Asn Gly Asp Gly Trp |     |     |
| 450   | 455 | 460 |
| Gly Glu Phe Phe Thr Asn Gly Gly Ser Val Ser Val Tyr Val Asn Gln |     |     |

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470

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480

&lt;210&gt;2

&lt;211&gt;485

&lt;212&gt;PRT

&lt;213&gt;Bacillus sp. KSM-AP1378

&lt;400&gt;2

His His Asn Gly Thr Asn Gly Thr Met Met Gln Tyr Phe Glu Trp His

5

10

15

Leu Pro Asn Asp Gly Asn His Trp Asn Arg Leu Arg Asp Asp Ala Ala

20

25

30

Asn Leu Lys Ser Lys Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Trp

35

40

45

Lys Gly Thr Ser Gln Asn Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr

50

55

60

Asp Leu Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly

65

70

75

80

Thr Arg Ser Gln Leu Gln Gly Ala Val Thr Ser Leu Lys Asn Asn Gly

85

90

95

Ile Gln Val Tyr Gly Asp Val Val Met Asn His Lys Gly Gly Ala Asp

100

105

110

Gly Thr Glu Met Val Asn Ala Val Glu Val Asn Arg Ser Asn Arg Asn

115

120

125

Gln Glu Ile Ser Gly Glu Tyr Thr Ile Glu Ala Trp Thr Lys Phe Asp

130

135

140

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Phe | Pro | Gly | Arg | Gly | Asn | Thr | His | Ser | Asn | Phe | Lys | Trp | Arg | Trp | Tyr |
| 145 |     |     |     |     | 150 |     |     |     |     | 155 |     |     |     |     | 160 |
| His | Phe | Asp | Gly | Thr | Asp | Trp | Asp | Gln | Ser | Arg | Gln | Leu | Gln | Asn | Lys |
|     |     |     |     | 165 |     |     |     |     | 170 |     |     |     |     | 175 |     |
| Ile | Tyr | Lys | Phe | Arg | Gly | Thr | Gly | Lys | Ala | Trp | Asp | Trp | Glu | Val | Asp |
|     |     |     |     | 180 |     |     |     |     | 185 |     |     |     |     | 190 |     |
| Ile | Glu | Asn | Gly | Asn | Tyr | Asp | Tyr | Leu | Met | Tyr | Ala | Asp | Ile | Asp | Met |
|     |     |     |     | 195 |     |     |     | 200 |     |     |     |     |     | 205 |     |
| Asp | His | Pro | Glu | Val | Ile | Asn | Glu | Leu | Arg | Asn | Trp | Gly | Val | Trp | Tyr |
|     |     |     |     | 210 |     |     |     | 215 |     |     |     | 220 |     |     |     |
| Thr | Asn | Thr | Leu | Asn | Leu | Asp | Gly | Phe | Arg | Ile | Asp | Ala | Val | Lys | His |
| 225 |     |     |     |     | 230 |     |     |     |     | 235 |     |     |     |     | 240 |
| Ile | Lys | Tyr | Ser | Tyr | Thr | Arg | Asp | Trp | Leu | Thr | His | Val | Arg | Asn | Thr |
|     |     |     |     |     | 245 |     |     |     | 250 |     |     |     |     | 255 |     |
| Thr | Gly | Lys | Pro | Met | Phe | Ala | Val | Ala | Glu | Phe | Trp | Lys | Asn | Asp | Leu |
|     |     |     |     | 260 |     |     |     |     | 265 |     |     |     |     | 270 |     |
| Ala | Ala | Ile | Glu | Asn | Tyr | Leu | Asn | Lys | Thr | Ser | Trp | Asn | His | Ser | Val |
|     |     |     |     | 275 |     |     |     |     | 280 |     |     |     |     | 285 |     |
| Phe | Asp | Val | Pro | Leu | His | Tyr | Asn | Leu | Tyr | Asn | Ala | Ser | Asn | Ser | Gly |
|     |     |     |     | 290 |     |     |     | 295 |     |     |     | 300 |     |     |     |
| Gly | Tyr | Phe | Asp | Met | Arg | Asn | Ile | Leu | Asn | Gly | Ser | Val | Val | Gln | Lys |
| 305 |     |     |     |     | 310 |     |     |     |     | 315 |     |     |     |     | 320 |
| His | Pro | Ile | His | Ala | Val | Thr | Phe | Val | Asp | Asn | His | Asp | Ser | Gln | Pro |
|     |     |     |     | 325 |     |     |     |     |     | 330 |     |     |     | 335 |     |
| Gly | Glu | Ala | Leu | Glu | Ser | Phe | Val | Gln | Ser | Trp | Phe | Lys | Pro | Leu | Ala |
|     |     |     |     | 340 |     |     |     |     |     | 345 |     |     |     | 350 |     |

Tyr Ala Leu Ile Leu Thr Arg Glu Gln Gly Tyr Pro Ser Val Phe Tyr  
 355 360 365  
 Gly Asp Tyr Tyr Gly Ile Pro Thr His Gly Val Pro Ser Met Lys Ser  
 370 375 380  
 Lys Ile Asp Pro Leu Leu Gln Ala Arg Gln Thr Tyr Ala Tyr Gly Thr  
 385 390 395 400  
 Gln His Asp Tyr Phe Asp His His Asp Ile Ile Gly Trp Thr Arg Glu  
 405 410 415  
 Gly Asp Ser Ser His Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asp  
 420 425 430  
 Gly Pro Gly Gly Asn Lys Trp Met Tyr Val Gly Lys His Lys Ala Gly  
 435 440 445  
 Gln Val Trp Arg Asp Ile Thr Gly Asn Arg Ser Gly Thr Val Thr Ile  
 450 455 460  
 Asn Ala Asp Gly Trp Gly Asn Phe Thr Val Asn Gly Gly Ala Val Ser  
 465 470 475 480  
 Val Trp Val Lys Gln  
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<213>Bacillus sp. KSM-K38

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<222>(225)..(1664)

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<222>(162)..(1664)

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ttttttccaa aaatgacatc atataaacia atttgtctac caatcactat ttaaagctgt 120
ttatgatata tgtaagcggt atcattaaaa ggaggtatgt g atg aga aga tgg gta 176
gta gca atg ttg gca gtg tta ttt tta ttt cct tgc gta gta gtt gca 224
gat gga ttg aac ggt acg atg atg cag tat tat gag tgg cat ttg gaa 272
Asp Gly Leu Asn Gly Thr Met Met Gln Tyr Tyr Glu Trp His Leu Glu
1 5 10 15
aac gac ggg cag cat tgg aat cgg ttg cac gat gat gcc gca gct ttg 320
Asn Asp Gly Gln His Trp Asn Arg Leu His Asp Asp Ala Ala Ala Leu
20 25 30
agt gat gct ggt att aca gct att tgg att ccg cca gcc tac aaa ggt 368
Ser Asp Ala Gly Ile Thr Ala Ile Trp Ile Pro Pro Ala Tyr Lys Gly
35 40 45
aat agt cag gcg gat gtt ggg tac ggt gca tac gat ctt tat gat tta 416
Asn Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu
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|   |     |     |     |
|---|-----|-----|-----|
| 50  | 55  | 60  |     |
| gga gag ttc aat caa aag ggt act gtt cga acg aaa tac gga act aag |     |     | 464 |
| Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys |     |     |     |
| 65  | 70  | 75  | 80  |
| gca cag ctt gaa cga gct att ggg tcc ctt aaa tct aat gat atc aat |     |     | 512 |
| Ala Gln Leu Glu Arg Ala Ile Gly Ser Leu Lys Ser Asn Asp Ile Asn |     |     |     |
| 85  | 90  | 95  |     |
| gta tac gga gat gtc gtg atg aat cat aaa atg gga gct gat ttt acg |     |     | 560 |
| Val Tyr Gly Asp Val Val Met Asn His Lys Met Gly Ala Asp Phe Thr |     |     |     |
| 100   | 105 | 110 |     |
| gag gca gtg caa gct gtt caa gta aat cca acg aat cgt tgg cag gat |     |     | 608 |
| Glu Ala Val Gln Ala Val Gln Val Asn Pro Thr Asn Arg Trp Gln Asp |     |     |     |
| 115   | 120 | 125 |     |
| att tca ggt gcc tac acg att gat gcg tgg acg ggt ttc gac ttt tca |     |     | 656 |
| Ile Ser Gly Ala Tyr Thr Ile Asp Ala Trp Thr Gly Phe Asp Phe Ser |     |     |     |
| 130   | 135 | 140 |     |
| ggg cgt aac aac gcc tat tca gat ttt aag tgg aga tgg ttc cat ttt |     |     | 704 |
| Gly Arg Asn Asn Ala Tyr Ser Asp Phe Lys Trp Arg Trp Phe His Phe |     |     |     |
| 145   | 150 | 155 | 160 |
| aat ggt gtt gac tgg gat cag cgc tat caa gaa aat cat att ttc cgc |     |     | 752 |
| Asn Gly Val Asp Trp Asp Gln Arg Tyr Gln Glu Asn His Ile Phe Arg |     |     |     |
| 165   | 170 | 175 |     |
| ttt gca aat acg aac tgg aac tgg cga gtg gat gaa gag aac ggt aat |     |     | 800 |
| Phe Ala Asn Thr Asn Trp Asn Trp Arg Val Asp Glu Glu Asn Gly Asn |     |     |     |
| 180   | 185 | 190 |     |
| tat gat tac ctg tta gga tcg aat atc gac ttt agt cat cca gaa gta |     |     | 848 |



|   |      |
|---|------|
| Tyr Asp Tyr Leu Leu Gly Ser Asn Ile Asp Phe Ser His Pro Glu Val |      |
| 195 200 205   |      |
| caa gat gag ttg aag gat tgg ggt agc tgg ttt acc gat gag tta gat | 896  |
| Gln Asp Glu Leu Lys Asp Trp Gly Ser Trp Phe Thr Asp Glu Leu Asp |      |
| 210 215 220   |      |
| ttg gat ggt tat cgt tta gat gct att aaa cat att cca ttc tgg tat | 944  |
| Leu Asp Gly Tyr Arg Leu Asp Ala Ile Lys His Ile Pro Phe Trp Tyr |      |
| 225 230 235 240   |      |
| aca tct gat tgg gtt cgg cat cag cgc aac gaa gca gat caa gat tta | 992  |
| Thr Ser Asp Trp Val Arg His Gln Arg Asn Glu Ala Asp Gln Asp Leu |      |
| 245 250 255   |      |
| ttt gtc gta ggg gaa tat tgg aag gat gac gta ggt gct ctc gaa ttt | 1040 |
| Phe Val Val Gly Glu Tyr Trp Lys Asp Asp Val Gly Ala Leu Glu Phe |      |
| 260 265 270   |      |
| tat tta gat gaa atg aat tgg gag atg tct cta ttc gat gtt cca ctt | 1088 |
| Tyr Leu Asp Glu Met Asn Trp Glu Met Ser Leu Phe Asp Val Pro Leu |      |
| 275 280 285   |      |
| aat tat aat ttt tac cgg gct tca caa caa ggt gga agc tat gat atg | 1136 |
| Asn Tyr Asn Phe Tyr Arg Ala Ser Gln Gln Gly Gly Ser Tyr Asp Met |      |
| 290 295 300   |      |
| cgt aat att tta cga gga tct tta gta gaa gcg cat ccg atg cat gca | 1184 |
| Arg Asn Ile Leu Arg Gly Ser Leu Val Glu Ala His Pro Met His Ala |      |
| 305 310 315 320   |      |
| gtt acg ttt gtt gat aat cat gat act cag cca ggg gag tca tta gag | 1232 |
| Val Thr Phe Val Asp Asn His Asp Thr Gln Pro Gly Glu Ser Leu Glu |      |
| 325 330 335   |      |

|   |      |
|---|------|
| tca tgg gtt gct gat tgg ttt aag cca ctt gct tat gcg aca att ttg | 1280 |
| Ser Trp Val Ala Asp Trp Phe Lys Pro Leu Ala Tyr Ala Thr Ile Leu |      |
| 340 345 350   |      |
| acg cgt gaa ggt ggt tat cca aat gta ttt tac ggt gat tac tat ggg | 1328 |
| Thr Arg Glu Gly Gly Tyr Pro Asn Val Phe Tyr Gly Asp Tyr Tyr Gly |      |
| 355 360 365   |      |
| att cct aac gat aac att tca gct aaa aaa gat atg att gat gag ctg | 1376 |
| Ile Pro Asn Asp Asn Ile Ser Ala Lys Lys Asp Met Ile Asp Glu Leu |      |
| 370 375 380   |      |
| ctt gat gca cgt caa aat tac gca tat ggc acg cag cat gac tat ttt | 1424 |
| Leu Asp Ala Arg Gln Asn Tyr Ala Tyr Gly Thr Gln His Asp Tyr Phe |      |
| 385 390 395 400   |      |
| gat cat tgg gat gtt gta gga tgg act agg gaa gga tct tcc tcc aga | 1472 |
| Asp His Trp Asp Val Val Gly Trp Thr Arg Glu Gly Ser Ser Ser Arg |      |
| 405 410 415   |      |
| cct aat tca ggc ctt gcg act att atg tcg aat gga cct ggt ggt tcc | 1520 |
| Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asn Gly Pro Gly Gly Ser |      |
| 420 425 430   |      |
| aag tgg atg tat gta gga cgt cag aat gca gga caa aca tgg aca gat | 1568 |
| Lys Trp Met Tyr Val Gly Arg Gln Asn Ala Gly Gln Thr Trp Thr Asp |      |
| 435 440 445   |      |
| tta act ggt aat aac gga gcg tcc gtt aca att aat ggc gat gga tgg | 1616 |
| Leu Thr Gly Asn Asn Gly Ala Ser Val Thr Ile Asn Gly Asp Gly Trp |      |
| 450 455 460   |      |
| ggc gaa ttc ttt acg aat gga gga tct gta tcc gtg tac gtg aac caa | 1664 |



|                             |                         |                     |
|-----------------------------|-------------------------|---------------------|
| 115                         | 120                     | 125                 |
| Ile Ser Gly Val Tyr Thr     | Ile Asp Ala Trp Thr     | Gly Phe Asp Phe Pro |
| 130                         | 135                     | 140                 |
| Gly Arg Asn Asn Ala Tyr Ser | Asp Phe Lys Trp Arg Trp | Phe His Phe         |
| 145                         | 150                     | 155                 |
| Asn Gly Val Asp Trp Asp     | Gln Arg Tyr Gln Glu Asn | His Leu Phe Arg     |
| 165                         | 170                     | 175                 |
| Phe Ala Asn Thr Asn Trp     | Asn Trp Arg Val Asp     | Glu Glu Asn Gly Asn |
| 180                         | 185                     | 190                 |
| Tyr Asp Tyr Leu Leu Gly Ser | Asn Ile Asp Phe Ser     | His Pro Glu Val     |
| 195                         | 200                     | 205                 |
| Gln Glu Glu Leu Lys Asp     | Trp Gly Ser Trp Phe Thr | Asp Glu Leu Asp     |
| 210                         | 215                     | 220                 |
| Leu Asp Gly Tyr Arg Leu Asp | Ala Ile Lys His Ile Pro | Phe Trp Tyr         |
| 225                         | 230                     | 235                 |
| Thr Ser Asp Trp Val Arg     | His Gln Arg Ser Glu Ala | Asp Gln Asp Leu     |
| 245                         | 250                     | 255                 |
| Phe Val Val Gly Glu Tyr Trp | Lys Asp Asp Val Gly Ala | Leu Glu Phe         |
| 260                         | 265                     | 270                 |
| Tyr Leu Asp Glu Met Asn Trp | Glu Met Ser Leu Phe Asp | Val Pro Leu         |
| 275                         | 280                     | 285                 |
| Asn Tyr Asn Phe Tyr Arg Ala | Ser Lys Gln Gly Gly Ser | Tyr Asp Met         |
| 290                         | 295                     | 300                 |
| Arg Asn Ile Leu Arg Gly Ser | Leu Val Glu Ala His Pro | Ile His Ala         |
| 305                         | 310                     | 315                 |
| Val Thr Phe Val Asp Asn     | His Asp Thr Gln Pro Gly | Glu Ser Leu Glu     |

|   |     |     |     |
|---|-----|-----|-----|
|   | 325 | 330 | 335 |
| Ser Trp Val Ala Asp Trp Phe Lys Pro Leu Ala Tyr Ala Thr Ile Leu |     |     |     |
|   | 340 | 345 | 350 |
| Thr Arg Glu Gly Gly Tyr Pro Asn Val Phe Tyr Gly Asp Tyr Tyr Gly |     |     |     |
|   | 355 | 360 | 365 |
| Ile Pro Asn Asp Asn Ile Ser Ala Lys Lys Asp Met Ile Asp Glu Leu |     |     |     |
|   | 370 | 375 | 380 |
| Leu Asp Ala Arg Gln Asn Tyr Ala Tyr Gly Thr Gln His Asp Tyr Phe |     |     |     |
| 385   | 390 | 395 | 400 |
| Asp His Trp Asp Ile Val Gly Trp Thr Arg Glu Gly Thr Ser Ser Arg |     |     |     |
|   | 405 | 410 | 415 |
| Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asn Gly Pro Gly Gly Ser |     |     |     |
|   | 420 | 425 | 430 |
| Lys Trp Met Tyr Val Gly Gln Gln His Ala Gly Gln Thr Trp Thr Asp |     |     |     |
|   | 435 | 440 | 445 |
| Leu Thr Gly Asn His Ala Ala Ser Val Thr Ile Asn Gly Asp Gly Trp |     |     |     |
|   | 450 | 455 | 460 |
| Gly Glu Phe Phe Thr Asn Gly Gly Ser Val Ser Val Tyr Val Asn Gln |     |     |     |
| 465   | 470 | 475 | 480 |

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<213>Bacillus sp. KSM-K36

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<221>sig\_peptide

<222>(40)..(102)

<220>

<221>mat\_peptide

<222>(103)..(1542)

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| gta gca atg ctg gca gtg tta ttt tta ttt cct tcg gta gta gtt gca | 102 |
| gat ggc ttg aat gga acg atg atg cag tat tat gag tgg cat cta gag | 150 |
| Asp Gly Leu Asn Gly Thr Met Met Gln Tyr Tyr Glu Trp His Leu Glu |     |
| 1 5 10 15   |     |
| aat gat ggg caa cac tgg aat cgg ttg cat gat gat gcc gaa gct tta | 198 |
| Asn Asp Gly Gln His Trp Asn Arg Leu His Asp Asp Ala Glu Ala Leu |     |
| 20 25 30  |     |
| agt aat gcg ggt att aca gct att tgg ata ccc cca gcc tac aaa gga | 246 |
| Ser Asn Ala Gly Ile Thr Ala Ile Trp Ile Pro Pro Ala Tyr Lys Gly |     |
| 35 40 45  |     |
| aat agt cag gct gat gtt ggg tat ggt gca tac gac ctt tat gat tta | 294 |
| Asn Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu |     |
| 50 55 60  |     |

|   |     |
|---|-----|
| ggg gag ttt aat caa aaa ggt acc gtt cga acg aaa tac ggg aca aag | 342 |
| Gly Glu Phe Asn Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys |     |
| 65 70 75 80   |     |
| gct cag ctt gag cga gct ata ggg tcc cta aag tcg aat gat atc aat | 390 |
| Ala Gln Leu Glu Arg Ala Ile Gly Ser Leu Lys Ser Asn Asp Ile Asn |     |
| 85 90 95  |     |
| gtt tat ggg gat gtc gta atg aat cat aaa tta gga gct gat ttc acg | 438 |
| Val Tyr Gly Asp Val Val Met Asn His Lys Leu Gly Ala Asp Phe Thr |     |
| 100 105 110   |     |
| gag gca gtg caa gct gtt caa gta aat cct tcg aac cgt tgg cag gat | 486 |
| Glu Ala Val Gln Ala Val Gln Val Asn Pro Ser Asn Arg Trp Gln Asp |     |
| 115 120 125   |     |
| att tca ggt gtc tac acg att gat gca tgg acg gga ttt gac ttt cca | 534 |
| Ile Ser Gly Val Tyr Thr Ile Asp Ala Trp Thr Gly Phe Asp Phe Pro |     |
| 130 135 140   |     |
| ggg cgc aac aat gcc tat tcc gat ttt aaa tgg aga tgg ttc cat ttt | 582 |
| Gly Arg Asn Asn Ala Tyr Ser Asp Phe Lys Trp Arg Trp Phe His Phe |     |
| 145 150 155 160   |     |
| aat ggc gtt gac tgg gat caa cgc tat caa gaa aac cat ctt ttt cgc | 630 |
| Asn Gly Val Asp Trp Asp Gln Arg Tyr Gln Glu Asn His Leu Phe Arg |     |
| 165 170 175   |     |
| ttt gca aat acg aac tgg aac tgg cga gtg gat gaa gag aat ggt aat | 678 |
| Phe Ala Asn Thr Asn Trp Asn Trp Arg Val Asp Glu Glu Asn Gly Asn |     |
| 180 185 190   |     |
| tat gac tat tta tta gga tcg aac att gac ttt agc cac cca gag gtt | 726 |
| Tyr Asp Tyr Leu Leu Gly Ser Asn Ile Asp Phe Ser His Pro Glu Val |     |

|   |     |     |      |
|---|-----|-----|------|
| 195   | 200 | 205 |      |
| caa gag gaa tta aag gat tgg ggg agc tgg ttt acg gat gag cta gat |     |     | 774  |
| Gln Glu Glu Leu Lys Asp Trp Gly Ser Trp Phe Thr Asp Glu Leu Asp |     |     |      |
| 210   | 215 | 220 |      |
| tta gat ggg tat cga ttg gat gct att aag cat att cca ttc tgg tat |     |     | 822  |
| Leu Asp Gly Tyr Arg Leu Asp Ala Ile Lys His Ile Pro Phe Trp Tyr |     |     |      |
| 225   | 230 | 235 | 240  |
| acg tca gat tgg gtt agg cat cag cga agt gaa gca gac caa gat tta |     |     | 870  |
| Thr Ser Asp Trp Val Arg His Gln Arg Ser Glu Ala Asp Gln Asp Leu |     |     |      |
| 245   | 250 | 255 |      |
| ttt gtc gta ggg gag tat tgg aag gat gac gta ggt gct ctc gaa ttt |     |     | 918  |
| Phe Val Val Gly Glu Tyr Trp Lys Asp Asp Val Gly Ala Leu Glu Phe |     |     |      |
| 260   | 265 | 270 |      |
| tat tta gat gaa atg aat tgg gag atg tct cta ttc gat gtt ccg ctc |     |     | 966  |
| Tyr Leu Asp Glu Met Asn Trp Glu Met Ser Leu Phe Asp Val Pro Leu |     |     |      |
| 275   | 280 | 285 |      |
| aat tat aat ttt tac cgg gct tca aag caa ggc gga agc tat gat atg |     |     | 1014 |
| Asn Tyr Asn Phe Tyr Arg Ala Ser Lys Gln Gly Gly Ser Tyr Asp Met |     |     |      |
| 290   | 295 | 300 |      |
| cgt aat att tta cga gga tct tta gta gaa gca cat ccg att cat gca |     |     | 1062 |
| Arg Asn Ile Leu Arg Gly Ser Leu Val Glu Ala His Pro Ile His Ala |     |     |      |
| 305   | 310 | 315 | 320  |
| gtt acg ttt gtt gat aat cat gat act cag cca gga gag tca tta gaa |     |     | 1110 |
| Val Thr Phe Val Asp Asn His Asp Thr Gln Pro Gly Glu Ser Leu Glu |     |     |      |
| 325   | 330 | 335 |      |
| tca tgg gtc gct gat tgg ttt aag cca ctt gct tat gcg aca atc ttg |     |     | 1158 |



|   |      |
|---|------|
| Ser Trp Val Ala Asp Trp Phe Lys Pro Leu Ala Tyr Ala Thr Ile Leu |      |
| 340 345 350   |      |
| acg cgt gaa ggt ggt tat cca aat gta ttt tac ggt gac tac tat ggg | 1206 |
| Thr Arg Glu Gly Gly Tyr Pro Asn Val Phe Tyr Gly Asp Tyr Tyr Gly |      |
| 355 360 365   |      |
| att cct aac gat aac att tca gct aag aag gat atg att gat gag ttg | 1254 |
| Ile Pro Asn Asp Asn Ile Ser Ala Lys Lys Asp Met Ile Asp Glu Leu |      |
| 370 375 380   |      |
| ctt gat gca cgt caa aat tac gca tat ggc aca caa cat gac tat ttt | 1302 |
| Leu Asp Ala Arg Gln Asn Tyr Ala Tyr Gly Thr Gln His Asp Tyr Phe |      |
| 385 390 395 400   |      |
| gat cat tgg gat atc gtt gga tgg aca aga gaa ggt aca tcc tca cgt | 1350 |
| Asp His Trp Asp Ile Val Gly Trp Thr Arg Glu Gly Thr Ser Ser Arg |      |
| 405 410 415   |      |
| cct aat tcg ggt ctt gct act att atg tcc aat ggt cct gga gga tca | 1398 |
| Pro Asn Ser Gly Leu Ala Thr Ile Met Ser Asn Gly Pro Gly Gly Ser |      |
| 420 425 430   |      |
| aaa tgg atg tac gta gga cag caa cat gca gga caa acg tgg aca gat | 1446 |
| Lys Trp Met Tyr Val Gly Gln Gln His Ala Gly Gln Thr Trp Thr Asp |      |
| 435 440 445   |      |
| tta act ggc aat cac gcg gcg tcg gtt acg att aat ggt gat ggc tgg | 1494 |
| Leu Thr Gly Asn His Ala Ala Ser Val Thr Ile Asn Gly Asp Gly Trp |      |
| 450 455 460   |      |
| ggc gaa ttc ttt aca aat gga gga tct gta tcc gtg tat gtg aac caa | 1542 |
| Gly Glu Phe Phe Thr Asn Gly Gly Ser Val Ser Val Tyr Val Asn Gln |      |
| 465 470 475 480   |      |

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